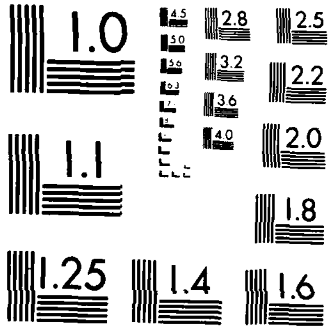
AD-A156 170 HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING REPORT 4(U) COASTAL ENGINEERING RESEARCH CENTER VICKSBURG MS J L DEAN ET AL. APR 85 CERC-83-9-4 1/1

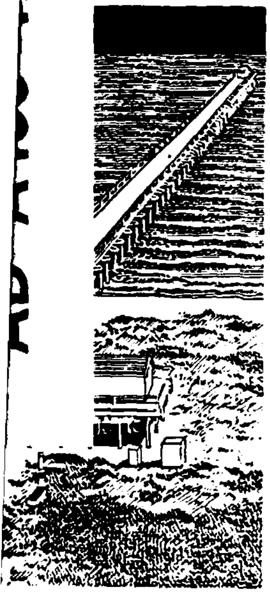
UNCLASSIFIED F/G 8/3 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

Army Corps
ngineers



(2)

MISCELLANEOUS PAPER CERC-83-9

HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING

REPORT 4

by

Julie L. Dean and Todd L. Walton, Jr.

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631
Vicksburg, Mississippi 39180-0631

April 1985
Report 4 of a Series

Approved For Public Release; Distribution Unlimited

Prepared for

DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Destroy this report when no longer needed. Do not return it to the originator.

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

The contents of this report are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Miscellaneous Paper CERC-83-9	2. GOVT ACCESSION NO. A156170	3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle) HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING; Report 4	5. TYPE OF REPORT & PERIOD COVERED Report 4 of a Series 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Julie L. Dean and Todd L. Walton, Jr.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Army Engineer Waterways Experiment Station Coastal Engineering Research Center PO Box 631, Vicksburg, Mississippi 39180-0631	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS DEPARTMENT OF THE ARMY US Army Corps of Engineers Washington, DC 20314-1000	12. REPORT DATE April 1985 13. NUMBER OF PAGES 45
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Calculator algorithm
Coastal engineering

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the fo[illegible] in a series of reports providing handheld calculator algorithms for use in coastal engineering. The first and second reports in this series were published as Coastal Engineering Technical Aids (CETA's), and are available from the US Army Engineer Waterways Experiment Station Technical Report Distribution Center, Vicksburg, Miss. Of these, CETA 82-1 presents a set of six algorithms for programs useful in performing certain wave transformation and wave generation calculations with both the Texas Instruments

(Continued)

20. ABSTRACT (Concluded).

TI-59 (Algebraic Operating System (AOS) notation) and the Hewlett-Packard HP-67 (Reverse Polish Notation (RPN)); CETA 82-4 presents the same six algorithms for use on the HP-41CV (RPN). The third report, Miscellaneous Paper CERC-83-9, Report 3, provides calculator algorithms for use with the HP-41CV that forecast gravity water waves in deep and shallow water.

The present report provides algorithms for three calculator programs intended for use with the HP-41CV. The first program computes the breaking wave forces on and moments about the base of vertical face structures using the Minikin method. The second program computes the non-breaking wave force and overturning moment at the base of vertical face structures using both the Miche-Rundgren and Sainflou equations. The last program computes the pressure distribution corresponding to the Miche-Rundgren and/or Sainflou solutions. The reference to these programs is the Shore Protection Manual (US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, 1984).

PREFACE

This report was prepared and published with funds provided by the Office, Chief of Engineers (OCE), through the Littoral Data Collection Methods and Engineering Application Research Work Unit of the Shore Protection and Restoration research program. Ms. Julie L. Dean, Civil Engineer, and Dr. Todd L. Walton, Research Hydraulic Engineer, Coastal Structures and Evaluation Branch, Coastal Engineering Research Center (CERC), prepared the report. The authors gratefully acknowledge the assistance of Messrs. Orson P. Smith and Robert B. Lund of the Coastal Design Branch, CERC, for their review of the report.

This report was prepared under general supervision of Dr. Robert W. Whalin, Chief, CERC, Dr. Fred E. Camfield, Acting Chief, Engineering Development Division, and Mr. Thomas Richardson, Chief, Coastal Structures and Evaluation Branch. During report review and publication, Dr. William L. Wood was Chief, Engineering Development Division.

Commanders and Directors of the US Army Engineer Waterways Experiment Station during the preparation and publication of this report were COL Tilford C. Creel, CE, and COL Robert C. Lee, CE. Mr. F. R. Brown was Technical Director.

CONTENTS

HANDHELD CALCULATOR ALGORITHMS FOR COASTAL ENGINEERING

PART I: INTRODUCTION

1. The advent of the handheld programmable calculator has led to the development of numerous programs in various fields of engineering and science. Coastal engineering is no exception. This report contains three programs, two of which compute breaking and non-breaking forces and moments on vertical face structures. The third program computes a non-breaking pressure distribution on vertical face structures. The reference to the programs is the Shore Protection Manual (SPM 1984).

2. The three programs presented herein are versions of Reverse Polish Notation (RPN) logic suitable for use on HP-41CV programmable calculators with or without accessory printer. Each program is documented, assumptions are briefly described, and references to more detailed presentations of the theory are given.

3. Each of the RPN programs incorporates HP-41 compatible print routines which print and label all input and output parameters. The user has only to enter the input parameters, and the results are automatically computed and printed. Since the printing routines increase program length by as much as 25 percent, use of a magnetic card for permanent program storage is recommended. The print steps do not need to be deleted if a printer is unavailable.

PART II: DEFINITION SKETCH AND PROGRAMS

4. Three programs (108, 109, 110) are presented in this report. Program 108 calculates the breaking wave force on and moment about the base of vertical face structures using Minikin's method. Program 109 computes the non-breaking wave force on and the overturning moment at the base of a vertical face structure using both the Miche-Rundgren and Sainflou equations. Program 110 calculates the non-breaking pressure distribution when either the wave crest or the wave trough is at the structure using the Miche-Rundgren and/or Sainflou equations.

5. Each program allows either US customary or metric input and output. Program listings are annotated, making it possible to follow the logic of the algorithm and to make modifications if desired.

6. There are undoubtedly many other calculator programs that have been developed on coastal engineering subjects. Practicing engineers are encouraged to submit them to the Coastal Engineering Research Center (CERC). If the response is great enough, additional reports presenting the programs will be prepared. Program authors will be given appropriate credit in these reports and will be included in the report review process. Comments, programs, or suggestions for programs should be sent to:

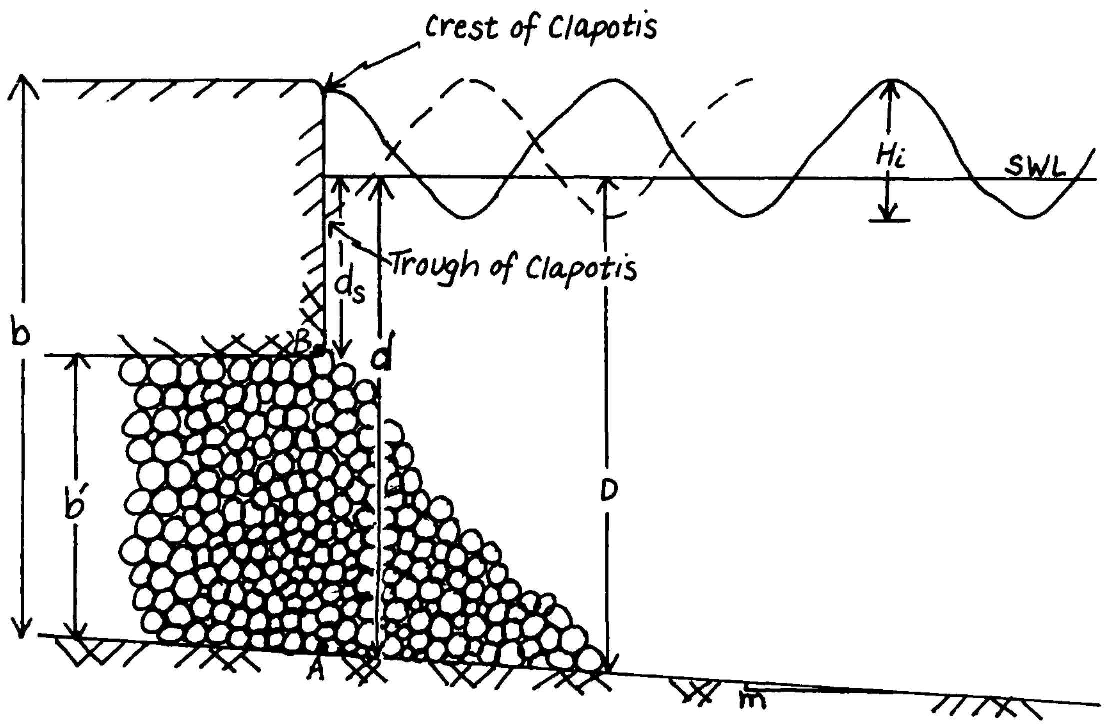
Commander and Director
US Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
ATTN: Coastal Structures and Evaluation Branch
PO Box 631
Vicksburg, Mississippi 39180-0631

7. These and future programs will generally correspond to the following numbering scheme:

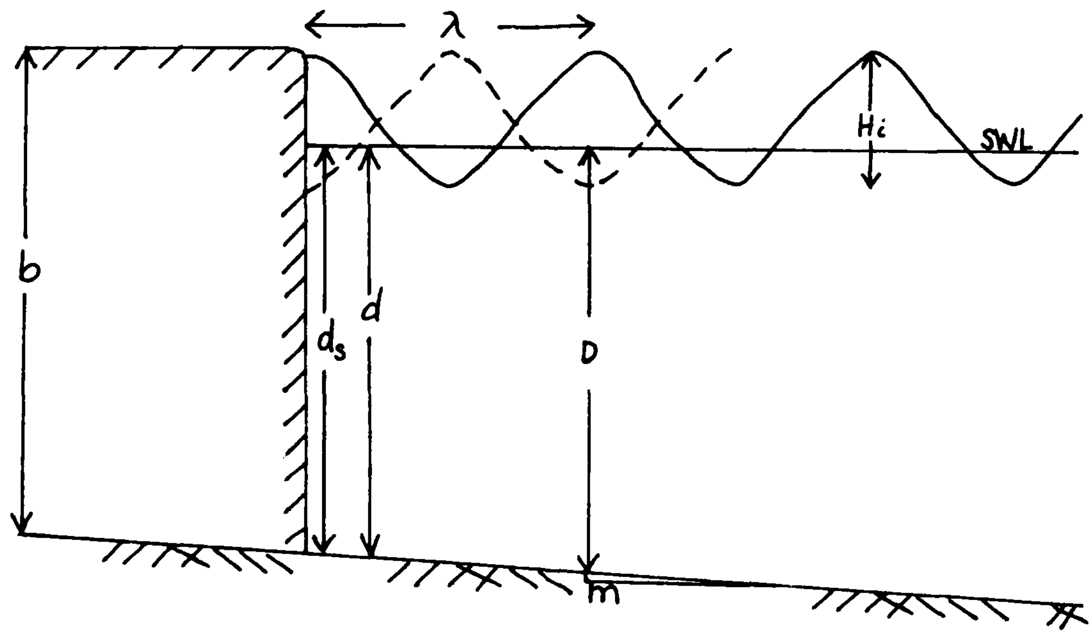
Miscellaneous	0-99
Waves and Currents	100-299
Inlets	300-499
Beaches	500-699
Geology	700-899
Structures	900-1099

8. In general, the documentation of programs submitted should be in a format paralleling that of the programs presented in this report. A blank set of forms which can be reproduced is included in Appendix A.

Definition Sketch of Input Values*



I. With Rubble Foundation



II. No Rubble Foundation

*Adapted from SPM Figures 7-100, 7-101.

Program Description

Program Title	108R-41CV Breaking Wave Forces and Moments on Vertical Face Structures - Minikin's Method (RPN Logic)		
Name	Julie Dean	**Date**	8/83
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center P. O. Box 631		
City	Vicksburg	**State** Mississippi	**Zip Code** 39180-0631

Program Description, Equations, Variables, etc.

This program calculates the breaking wave force on and moment about the base of vertical face structures using Minikin's Method (Shore Protection Manual, 1984). Input values are the water depth at the structure, d_s, the height of the structure, b, the unit weight of water, γ_w, the wave period, T, and the nearshore bottom slope, m. If the structure is founded on a rubble base, the program will ask for the water depth D at the toe of the foundation; if no substructure is present, a water depth D will be calculated at a distance one wavelength seaward of the structure. If the top of the structure is lower than the crest of the design breaker, reduced forces and moments will be calculated.

The wavelength used in the program is calculated using an explicit formula (Nielsen, 1982). The breaker height H_b is calculated using equations (2-92), (2-93), (2-94), (7-3), and (7-4) of the Shore Protection Manual (see program 104R-41CV, CETA 82-4). For a nearshore bottom slope of zero, breaker height is given by $H_b = 0.78d_s$.

The algorithms use either the U. S. Customary or Metric system of units.

REFERENCES

Nielsen, P., "Explicit Formulae for Practical Wave Calculations," Coastal Engineering, p. 389-398, 1982.

U. S. Army, Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapters 2 and 7 (1984).

Walton, T. L., "Hand-Held Calculator Algorithms for Coastal Engineering (Second Series)," Coastal Engineering Technical Aid No. 82-4, U. S. Army Corps of Engineers, November 1982.

Operating Limits and Warnings

User Instructions

108R-41CV BREAKING WAVE FORCES AND MOMENTS ON VERTICAL FACE STRUCTURES MINIKIN METHOD

SIZE: 019

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	LOAD PROGRAM (BWF)		[XEQ] "BWF"	E OR M?
2	CHOOSE U.S. CUSTOMARY OR METRIC			
	UNITS		US or M, [R/S]	d_s?
3	ENTER DEPTH AT TOE OF			
	WALL, d_s (feet or meters)	d_s	[R/S]	b?
4	ENTER WALL HEIGHT, b			
	(feet or meters)	b	[R/S]	UNIT WT.?
5	ENTER UNIT WEIGHT OF			
	WATER (lb/ft^3 or kg/m^3)	γ_{water}	[R/S]	T?
6	ENTER WAVE PERIOD (sec.)	T	[R/S]	SLOPE?
7	ENTER NEARSHORE SLOPE	m	[R/S]	RUBBLE FDN?
8	ANSWER YES OR NO TO			
	RUBBLE FOUNDATION OPTION		Y or N, [R/S]	
	- IF YES, INPUT DEPTH			
	AT TOE OF SUBSTRUCTURE			
	(feet or meters)	D	[R/S]	
	- IF NO, DEPTH D IS CALCU-			
	LATED IN PROGRAM			
9	READ FORCE (lb/ft or kg/m)			"FORCE = "
	READ MOMENT (ft-lb/ft or kg-m/m)			"MOMENT= "

108R-41CV-2

User Instructions

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	EXAMPLE PROBLEM:			
	d_s = 7.5 ft. = 2.286 m			
	b = 10 ft. = 3.048 m			
	γ_w = 64 lb/ft^3 = 1025.18 Kg/m^3			
	T = 6 sec			
	m = 0.05			

```
BREAKING WAVE FORCES
US CUST. UNITS
DS=
            7.5000    ***
B=
           10.0000    ***
UNIT WT WATER=
           64.0000    ***
T=
            6.0000    ***
M=
            0.0500    ***
FORCE=38,776.[illegible]
MOMENT=172,[illegible]
```

```
BREAKING WAVE FORCES
METRIC UNITS
DS=
            2.2860    ***
B=
            3.0480    ***
UNIT WT WATER=
        1 025.1843    ***
T=
            6.0000    ***
M=
            0.0500    ***
FORCE=30,922.79[illegible]
MOMENT=52,769.6[illegible]
```

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	Note that the moment cal-			
	culated when a rubble foun-			
	dation exists is the moment			
	at the base of the founda-			
	tion (Point A), not the base			
	of the structure (point B).			
	The moment at point B can			
	be calculated:			
	$M = M_A - b'F''$			
	where b' = height of rubble foundation			
	F'' = reduced force on wall			
	See Definition Sketch			

108R-41CV-3

User Instructions

SIZE:

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	EXAMPLE PROBLEM:			
	depth = 10' = 3.048 m			
	T = 6 sec			
	χ = 1.0			
	$\gamma_w = 64\ ^{lb}/_{ft^3} = 1025.184\ ^{kg}/_{m^3}$			
	Choose:			
	low wall height option			
	wall ht. = 10' = 3.048 m			
	rubble foundation option			
	rubble ht. = 5' = 1.524 m			
	Read:			
	Force in lb/ft or kg/m			
	Moment in lb-ft/ft or kgm/m			
	Sainflou theory gives the			
	values predicted by			
	SPM Figures 7-90, 7-91, 7-92.			
	Note that the moment calculated			
	when a rubble foundation exists			
	is the moment at the base of			
	the foundation, not at the base			
	of the structure.			
	The moment at the toe of the structure can be found from			
	$M_{toe\ of\ structure} = M_{base\ of\ fdn.} - b'F''$			
	where b' = height of rubble foundation			
	and F'' = reduced force on wall.	See Fig. 7-98 (SPM) or Definition Sketch.		

```
NON-BREAKING WAVE FORCE.

US CUST. UNITS

DEPTH=
        10.0000    ***
PERIOD=
         6.0000    ***
WAVE HT.=
         5.0000    ***
REFLECTION COEFF.=
         1.0000    ***
UNIT WT. WATER=
        64.0000    ***

YC-MR=18.5929
YT-MR=8.5929
YC-SF=16.4053
YT-SF=6.4053


WALL HT=
        10.0000    ***
RUBBLE HT=
         5.0000    ***

MICHE-R
PC=2,83[illegible]
PT=[illegible]
MC=[illegible]
MT=1,[illegible]2.4417

SAINFLOU
PC=2,440.2858
PT=58.7174
MC=17,203.5087
MT=723.7641
```

```
NON-BREAKING WAVE FORCE.

METRIC UNITS

DEPTH=
         3.0480    ***
PERIOD=
         6.0000    ***
WAVE HT.=
         1.5240    ***
REFLECTION COEFF.=
         1.0000    ***
UNIT WT. WATER=
     1,025.1840    ***

YC-MR=5.6667
YT-MR=2.6187
YC-SF=5.0004
YT-SF=1.9524


WALL HT=
         3.0480    ***
RUBBLE HT=
         1.5240    ***

MICHE-R
PC=4,224.0724
PT=494.2136
MC=1,9[illegible]5.6261
MT=957.7[illegible]

SAINFLOU
PC=3,631.4595
PT=87.3962
MC=7,803.0811
MT=146.8834
```

109R-41CV-9

User Instructions

STEP	INSTRUCTIONS	INPUT	FUNCTION	SIZE: DISPLAY
12	READ MICHE-RUNDGREN*			MICHE-R
	FORCE WITH CREST AT WALL (lb/ft or kg/m)			P_c =
	FORCE WITH TROUGH AT WALL (lb/ft or kg/m)		R/S	P_t =
	MOMENT WITH CREST AT WALL (lb-ft/ft or kg-m/m)		R/S	M_c =
	MOMENT WITH TROUGH AT WALL (lb-ft/ft or kg-m/m)		R/S	M_t =
13	READ SAINFLOU*		R/S	SAINFLOU
	FORCE WITH CREST AT WALL (lb/ft or kg/m)			P_c =
	FORCE WITH TROUGH AT WALL (lb/ft or kg/m)		R/S	P_t =
	MOMENT WITH CREST AT WALL (lb-ft/ft or kg-m/m)		R/S	M_c =
	MOMENT WITH TROUGH AT WALL (lb-ft/ft or kg-m/m)		R/S	M_t =
	*The solution giving lower values			
	of force and moment is the solution			
	that corresponds to SPM Figures			
	7-91, 7-92, 7-93, 7-94, and 7-95.			
	Note:			
	SPM Figure 7-90 plots the			
	Miche-Rundgren theory for large			
	values of H_i/gT^2; but as H_i/gT^2			
	approaches zero, the curves are			
	constrained to pass through $h_o/H_i = 1.0$			
	For small values of H_i/gT^2, the			
	program's y_c and y_t may not			
	correspond to the Shore Protection			
	Manual's.			

109R-41CV-8

User Instructions

109R-41CV - Non-Breaking Wave Forces and Moments on Vertical-Face Structures - Miche-Rundgren and Sainflou Equations

SIZE: 058

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	BEGIN PROGRAM		[XEQ] "NBWF"	E OR M ?
2	CHOOSE U.S. CUSTOMARY OR			
	METRIC UNITS		US or M [RS]	DEPTH ?
3	ENTER DEPTH (feet or meters)	d	[R/S]	PERIOD?
4	ENTER WAVE PERIOD (seconds)	T	[R/S]	WAVE HT.?
5	ENTER WAVE HEIGHT (feet or meters)	H_i	[R/S]	REFLEC. COEFF?
6	ENTER REFLECTION COEFFICENT	χ	[R/S]	UNIT WT. ?
7	ENTER UNIT WT. OF WATER			
	(lb/ft^3 or kg/m^3)	γ_w	[R/S]	
8	READ MICHE - RUNDGREN			
	Height of crest above bottom			YC-MR=
	Height of trough above bottom			YT-MR =
	READ SAINFLOU			
	Height of crest above bottom			YC-SF=
	Height of trough above bottom			YT-SF=
				LOW WALL HT?
9	CHOOSE LOW WALL HT. OPTION?		Y or N, [R/S]	
	IF YES			WALL HT.?
	ENTER WALL HEIGHT (ft or m)	b	[R/S]	RUBBLE FDN?
10	CHOOSE RUBBLE FOUNDATION OPTION?		Y or N, [R/S]	
	IF YES			RUBBLE HT.?
	ENTER HEIGHT OF RUBBLE			
	FOUNDATION (feet or meters)	b'	[R/S]	
	(continued on next page)			

109R-41CV-7

REDUCTION FACTORS

$$F_{\text{low wall}} = r_f \cdot F_T$$

$$F_{\text{rubble}} = F_T - r_f' \cdot F_T$$

$$F_{\text{low wall \& rubble}} = r_f \cdot F_T - r_f' \cdot F_T$$

Where $$r_f = \frac{b}{y}\left(2 - \frac{b}{y}\right)$$

$$r_f' = \frac{b'}{y}\left(2 - \frac{b'}{y}\right)$$

$$M_{\text{low wall}} = r_m \cdot M_T$$

$$M_{\text{rubble}} = M_T - r_m' \cdot M_T$$

$$M_{\text{low wall \& rubble}} = r_m \cdot M_T - r_m' \cdot M_T$$

Where $$r_m = \left(\frac{b}{y}\right)^2\left(3 - 2\frac{b}{y}\right)$$

$$r_m' = \left(\frac{b'}{y}\right)^2\left(3 - 2\frac{b'}{y}\right)$$

Miche-Rundgren:

$$Y_c(K) = Y_o + H_i(1+\chi)\cdot F1/2 + (\pi\cdot H_i^2\cdot F1\cdot F2/4\cdot L)\left((1+\chi)^2\cdot F5+(1-\chi)^2\cdot F6\right)$$

$$Y_t(K) = Y_c(K) - (1+\chi)H_i\cdot F1$$

$$P1 = -Y_o - H_i(1+\chi)\cdot F4/2 -\left(\pi\cdot H_i^2\cdot F3/4\cdot L\right)\left((1+\chi)^2\cdot F7+(1-\chi)^2\cdot F8\right)$$

$P_c(K) = \gamma\cdot P1$ . . . . crest interval pressure

$P_t(K) = P_c(K) + \gamma\cdot H_i\ (1+\chi)\cdot F4$ . . . . trough interval pressure

$M_c(K) = P_c(K)\cdot(Y_c(K)+d)$ . . . . crest interval moment

$M_t(K) = P_t(K)\cdot(Y_t(K)+d)$ . . . . trough interval moment

Sainflou:

$$Y_c(K) = Y_o + H_i\cdot F1 + \pi\cdot H_i^2\cdot F1\cdot F2/L$$

$$Y_t(K) = Y_c(K) - 2\cdot H_i\cdot F1$$

$$P1 = -Y_o - H\cdot F4$$

$P_c(K) = \gamma\ P1$ . . . . crest interval pressure

$P_t(K) = (H\cdot F4-Y_o)\cdot\gamma$ . . . . trough interval pressure

$M_c(K) = P_c(K)\ (Y_c(K)+d)$ . . . . crest interval moment

$M_t(K) = P_t(K)\ (Y_t(K)+d)$ . . . . trough interval moment

109R-41CV-5

EQUATIONS USED

$$Gt = \left(\frac{2\pi}{T}\right)^2 \frac{d}{g}$$

$$Fterm = Gt + (1 + 0.6522Gt + 0.4622Gt^2 + 0.0864Gt^3 + 0.0675Gt^4)^{-1}$$

$$L = T(G \cdot d/Fterm)^{1/2}$$

$$\Delta = d/L$$

$$C1 = \cosh(2\pi\Delta)$$

$$S1 = \sinh(2\pi\Delta)$$

$$T1 = \tanh(2\pi\Delta)$$

$$F5 = 1 + 3/4(S1)^2 - 1/4(C1)^2$$

$$F6 = 3/4(S1)^2 + 1/4(C1)^2$$

N = number of intervals

$$Dd = d/N$$

$$E = Yo/L$$

$$C2 = \cosh(2\pi(\Delta+E))$$

$$S2 = \sinh(2\pi(\Delta+E))$$

$$C3 = \cosh(2\pi(2\Delta+E))$$

$$S3 = \sinh(2\pi(2\Delta+E))$$

$$C4 = \cosh(2\pi E)$$

$$S4 = \sinh(2\pi E)$$

$$F1 = S2/S1$$

$$F2 = C2/S1$$

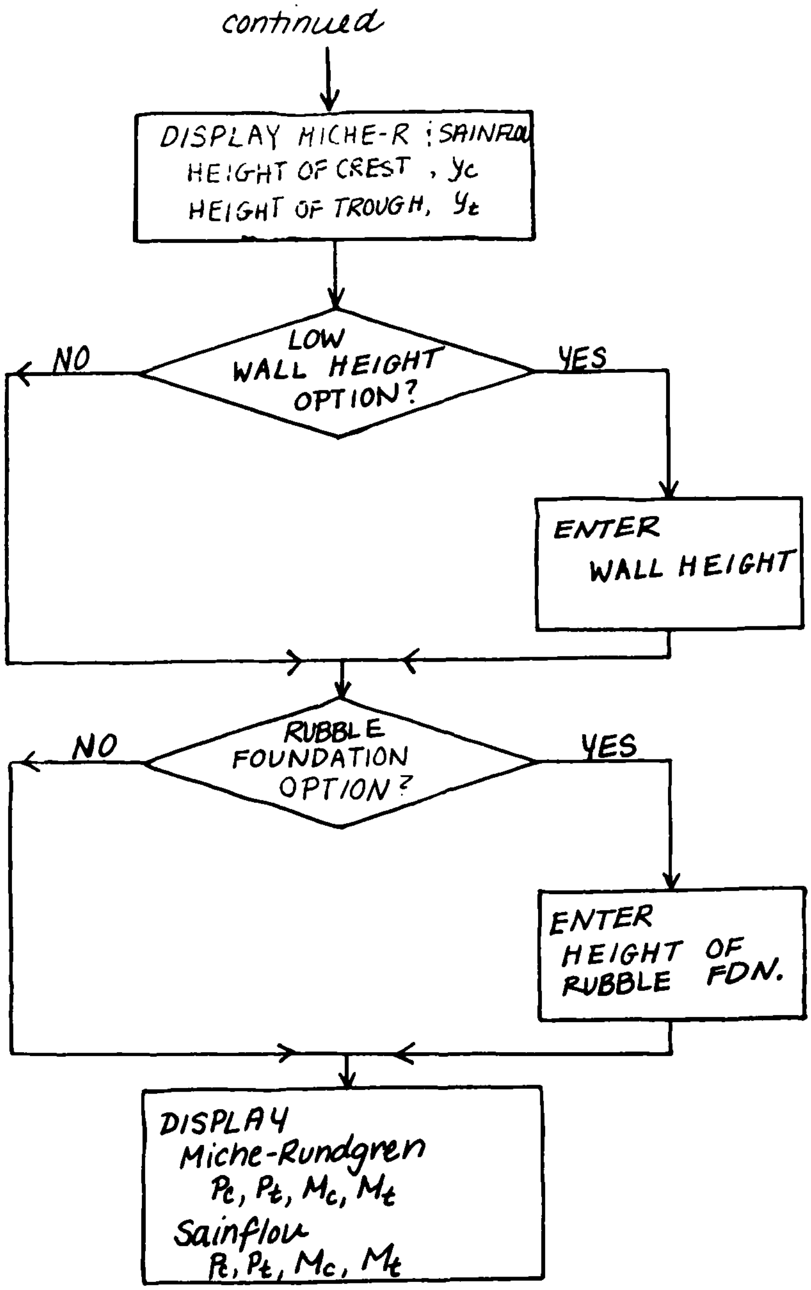
$$F3 = S4/(S1)^2$$

$$F4 = S4/(S1)(C1)$$

$$F7 = \left(1 - 1/4(C1)^2\right) C3 - 2 \cdot T1 \cdot S3 + 0.75\left(C4/(S1)^2 - 2 \cdot C2/C1\right)$$

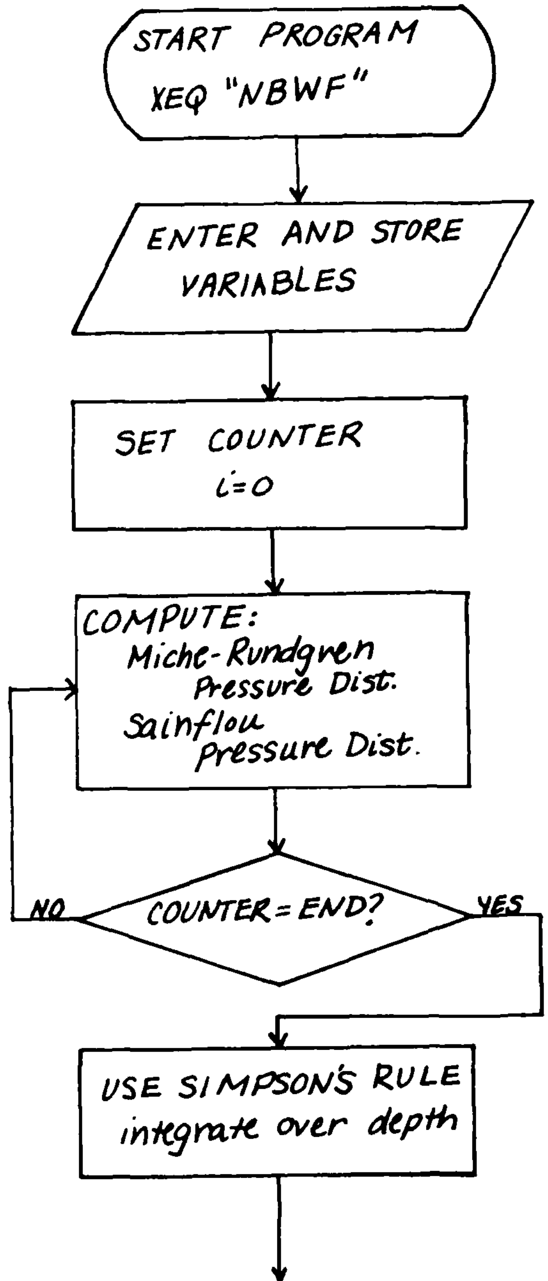
$$F8 = C3/4\ (C1)^2 - 2 \cdot T1 \cdot S3 + 0.75\left(C4/(S1)^2 - 2 \cdot C2/C1\right)$$

109R-41CV-4


continued
DISPLAY MICHE-R ; SAINFLOU
HEIGHT OF CREST , y_c
HEIGHT OF TROUGH, y_t
LOW WALL HEIGHT OPTION?
NO
YES
ENTER WALL HEIGHT
RUBBLE FOUNDATION OPTION?
NO
YES
ENTER HEIGHT OF RUBBLE FDN.
DISPLAY
Miche-Rundgren
P_c, P_t, M_c, M_t
Sainflou
P_c, P_t, M_c, M_t

109R-41CV-3

Program "NBWF" Flowchart



next page

109R-41CV

Program Description

Program Title	109R-41CV Non-Breaking Wave Forces and Moments on Vertical-Face Structures - Miche-Rundgren and Sainflou Equations (RPN Logic)
Name	Julie Dean — **Date** 6/83
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center P. O. Box 631
City	Vicksburg — **State** Mississippi — **Zip Code** 39180-0631

Program Description, Equations, Variables, etc.

This program computes the non-breaking wave force and overturning moment at the base of vertical face structures (including the hydrostatic components) given the reflection coefficient, χ, depth of water, d, wave period, T, incident wave height, H_i, and unit weight of water, γ_w. The force and moment are calculated using both the Miche-Rundgren and Sainflou equations; the Miche-Rundgren theory is more accurate for steeper waves, while the theory of Sainflou gives better results for long, low-steepness waves. The program can be used in lieu of figures 7-90, 7-91, 7-92, 7-93, 7-94, and 7-95 in the Shore Protection Manual (SPM); see also CETN I-21, 12/82.

The program outputs the wave forces and moments at the wall for crest and trough for both the Miche-Rundgren and Sainflou cases with the option of calculating the reduced force and moment due to a low height wall and/or a rubble foundation. The solution with the lower values of force and moment is the solution as given by SPM figures 7-90, 7-91, 7-92, 7-93, 7-94, and 7-95. If a rubble foundation exists, the moment calculated is the moment at the base of the foundation, i.e. sea bottom, not at the base of the structure. The algorithm uses either U. S. Customary or Metric system of units.

<u>REFERENCES</u>

Hughes, S. A., August 1982, Basic Program: "WAVEFOR", available from Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss. 39180-0631.

U. S. Army Corps of Engineers, Coastal Engineering Research Center, CETN-I-21, 12/82.

U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapter 7, (1984).

Operating Limits and Warnings

STEP	KEY ENTRY	KEY CODE	COMMENTS
345	RCL 15		
346	RCL 14		
347	*		
348	+		
349	RCL 17		
350	*		
351	RCL 12		
352	2		
353	/		
354	RCL 01		
355	+		
356	3		
357	/		
358	RCL 16		
359	*		
360	+		
361	"MOMENT="		"Moment="
362	ARCL X		
363	TONE 9		
364	AVIEW		
365	STOP		
366	GTO 09		
367	♦LBL 03		
368	PRA		
369	PRX		
370	RTN		
371	.END.		

108R-41CV-8

STEP	KEY ENTRY	KEY CODE	COMMENTS
232	/		
233	STO 15		$a \rightarrow R_{15}$
234	GTO 08		
235♦	LBL 06		
236	RCL 13		
237	0.5		
238	X<>Y		
239	X<Y?		$x < 0.5?$
240	GTO 07		
241	RCL 13		
242	3.0		
243	Y↑X		
244	4		
245	*		
246	RCL 13		
247	X↑2		
248	12		
249	*		
250	-		
251	RCL 13		
252	12		
253	*		
254	+		
255	3		
256	-		
257	STO 14		$r_m \rightarrow R_{14}$
258	RCL 13		
259	0.75		
260	*		
261	0.25		
262	-		
263	RCL 12		
264	*		
265	STO 15		$a \rightarrow R_{15}$
266	GTO 08		
267♦	LBL 07		
268	RCL 13		
269	3.0		
270	Y↑X		
271	4		
272	*		
273	STO 14		$r_m \rightarrow R_{14}$
274	RCL 13		
275	3.0		
276	Y↑X		
277	2		
278	*		
279	RCL 12		
280	*		
281	RCL 13		
282	4.0		
283	Y↑X		
284	RCL 12		
285	*		
286	3.0		
287	*		

STEP	KEY ENTRY	KEY CODE	COMMENTS
288	-		
289	RCL 13		
290	3.0		
291	Y↑X		
292	4.0		
293	*		
294	CHS		
295	1		
296	+		
297	1/X		
298	*		
299	STO 15		$a \rightarrow R_{15}$
300♦	LBL 08		
301	RCL 12		
302	2		
303	/		
304	RCL 01		
305	+		
306	X↑2		
307	RCL 03		
308	2.		
309	/		
310	*		
311	STO 16		$R_5 \rightarrow R_{16}$
312	RCL 01		
313	RCL 05		
314	+		
315	RCL 01		
316	*		
317	RCL 05		
318	/		
319	RCL 12		
320	*		
321	RCL 06		
322	/		
323	RCL 03		
324	*		
325	101		
326	*		
327	RCL 12		
328	*		
329	3		
330	/		
331	STO 17		$R_m \rightarrow R_{17}$
332	RCL 14		
333	*		
334	RCL 16		
335	+		
336	"FORCE="		"Force="
337	ARCL X		
338	TONE 8		
339	AVIEW		
340	RCL 01		
341	RCL 14		
342	*		
343	RCL 15		
344	-		

108R-41CV-7

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
118	/			175	-		
119	RCL 05			176	CHS		
120	-			177	RCL 18		
121	RCL 05			178	*		
122	RCL 00			179	STO 10		$m\tau_p = m(4-9.25m) \rightarrow R_{10}$
123	/			180	RCL 09		
124	SQRT			181	*		
125	*			182	1		
126	2			183	-		
127	*			184	RCL 07		
128	PI			185	RCL 08		
129	*			186	*		
130	RCL 04			187	-		
131	/			188	STO 11		$m\tau_p b - a\hat{d}_s - 1 \rightarrow R_{11}$
132	STO 06		$L_D \rightarrow R_{06}$	189	X↑2		
133	RCL 18			190	4		
134	X≠0?			191	RCL 08		
135	GTO 10		if $m=0$	192	*		
136	RCL 01			193	RCL 09		
137	0.78		$H_b = 0.78 d_s$	194	*		
138	*			195	RCL 10		
139	GTO 11			196	*		
140	♦LBL 10			197	RCL 07		
141	RCL 04			198	*		
142	X↑2			199	+		
143	RCL 00			200	SQRT		
144	*			201	RCL 11		
145	1/X			202	+		
146	RCL 01			203	2		
147	*			204	/		
148	STO 07		$\frac{d_s}{gT^2} \rightarrow R_{07}$	205	RCL 08		
149	RCL 18			206	/		
150	19			207	RCL 10		
151	*			208	/		
152	CHS			209	RCL 07		
153	E↑X			210	/		
154	CHS			211	RCL 01		
155	1			212	*		
156	+			213	♦LBL 11		
157	43.75			214	STO 12		$H_b \rightarrow R_{12}$
158	*			215	2		
159	STO 08		$43.75(1-e^{-19m}) \rightarrow R_{08}$	216	/		
160	RCL 18			217	RCL 01		
161	19.5			218	-		
162	*			219	RCL 02		
163	CHS			220	+		
164	E↑X			221	RCL 12		
165	1			222	/		
166	+			223	STO 13		$X = \frac{b'}{H_b} \rightarrow R_{13}$
167	1.56			224	1.0		
168	/			225	X<>Y		$X \geq 1.0$?
169	1/X			226	X<Y?		
170	STO 09		$\frac{1.56}{(1.+e^{-19.5m})} \rightarrow R_{09}$	227	GTO 06		
171	RCL 18			228	1.0		
172	9.25			229	STO 14		$Y_m \rightarrow R_{14}$
173	*			230	RCL 12		
174	4			231	2		

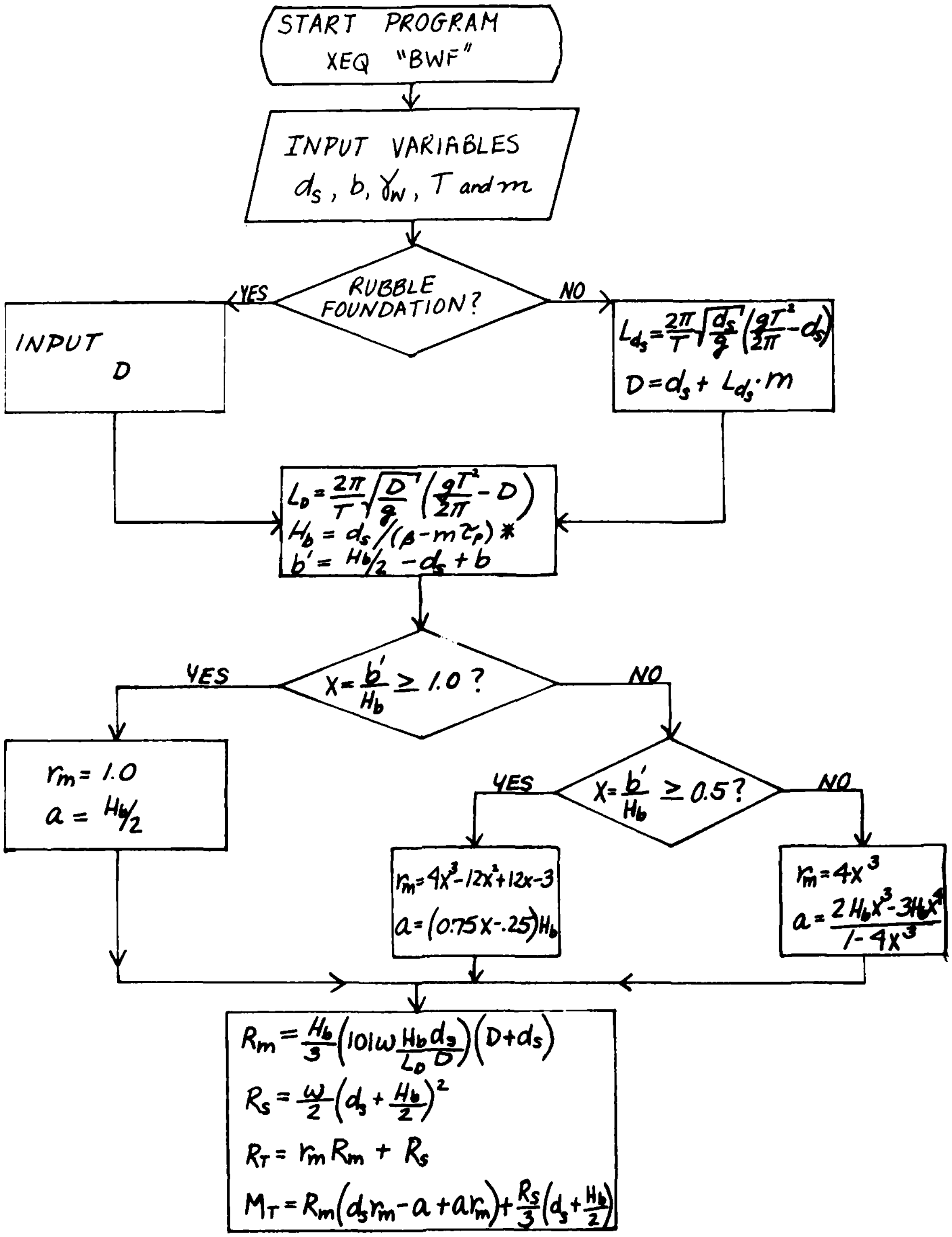
108R-41CV-6

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	♦LBL "BWF"		
02	"BREAKING WAVE F"		
03	"FORCES"		
04	AVIEW		
05	♦LBL 09		
06	"US OR M?"		
07	AON		
08	TONE 0		
09	PROMPT		
10	AOFF		
11	ASTO Y		
12	CLA		
13	"US"		
14	ASTO X		
15	CLA		
16	X=Y?		
17	GTO 01		
18	"METRIC UNITS"		
19	AVIEW		
20	9.81		
21	GTO 02		
22	♦LBL 01		
23	"US CUST. UNITS"		
24	AVIEW		
25	32.2		
26	♦LBL 02		
27	STO 00		$g \rightarrow R_{00}$
28	"DS?"		
29	TONE 1		
30	PROMPT		
31	"DS="		
32	FS? 55		
33	XEQ 03		
34	STO 01		$d_s \rightarrow R_{01}$
35	"B?"		
36	TONE 2		
37	PROMPT		
38	"B="		
39	FS? 55		
40	XEQ 03		
41	STO 02		$b \rightarrow R_{02}$
42	"UNIT WT?"		
43	TONE 3		
44	PROMPT		
45	"UNIT WT WATER="		
46	FS? 55		
47	XEQ 03		
48	STO 03		$\gamma_{water} \rightarrow R_{03}$
49	"T?"		
50	TONE 4		
51	PROMPT		
52	"T="		
53	FS? 55		
54	XEQ 03		
55	STO 04		$T \rightarrow R_{04}$
56	"SLOPE ?"		
57	TONE 5		
58	PROMPT		
59	"M="		
60	FS? 55		
61	XEQ 03		
62	STO 18		$m \rightarrow R_{18}$
63	"RUBBLE FDN?"		
64	AON		
65	TONE 6		
66	PROMPT		
67	AOFF		
68	ASTO Y		
69	CLA		
70	"Y"		
71	ASTO X		
72	CLA		
73	X≠Y?		
74	GTO 04		
75	"D?"		
76	TONE 7		
77	PROMPT		
78	"D="		
79	FS? 55		
80	XEQ 03		
81	STO 05		$D \rightarrow R_{05}$
82	GTO 05		
83	♦LBL 04		
84	RCL 04		
85	X↑2		
86	RCL 00		
87	*		
88	2		
89	/		
90	PI		
91	/		
92	RCL 01		
93	-		
94	RCL 01		
95	RCL 00		
96	/		
97	SQRT		
98	*		
99	2		
100	*		
101	PI		
102	*		
103	RCL 04		
104	/		
105	RCL 18		
106	*		
107	RCL 01		
108	+		
109	STO 05		$D \rightarrow R_{05}$
110	♦LBL 05		
111	RCL 04		
112	X↑2		
113	RCL 00		
114	*		
115	2		
116	/		
117	PI		

108R-41CV-5

Flowchart for "BWF"



*See program 104R-41CV (CETA 82-4) for equations used in calculating H_b.

108R-41CV-4

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS
01	◆LBL "[illegible]"		
02	"NON-BREAKING WA"		
03	"VE FORCES"		
04	AVIEW		
05	[illegible]		
06	[illegible]		
07	◆LBL 11		
08	CLRG		
09	CF 01		
10	CF 02		
11	"US OR M?"		
12	AON		
13	PROMPT		
14	AOFF		
15	ASTO Y		
16	CLA		
17	"US"		
18	ASTO X		
19	CLA		
20	X=Y?		
21	GTO 02		
22	"METRIC UNITS"		
23	AVIEW		
24	9.81		
25	GTO 03		
26	◆LBL 02		
27	"US CUST. UNITS"		
28	AVIEW		
29	32.2		
30	◆LBL 03		
31	STO 00		$g \rightarrow R_{00}$
32	FS? 55		
33	ADV		
34	"DEPTH?"		
35	PROMPT		
36	"DEPTH="		
37	FS? 55		
38	XEQ 01		
39	STO 01		$d \rightarrow R_{01}$
40	"PERIOD?"		
41	PROMPT		
42	"PERIOD="		
43	FS? 55		
44	XEQ 01		
45	STO 02		$T \rightarrow R_{02}$
46	"WAVE HT.?"		
47	PROMPT		
48	"WAVE HT.="		
49	FS? 55		
50	XEQ 01		
51	STO 03		$H_i \rightarrow R_{03}$
52	"REFLEC. COEFF?"		
53	PROMPT		
54	"REFLECTION COEF"		
55	"F.="		
56	FS? 55		
57	XEQ 01		
58	STO 04		$\chi \rightarrow R_{04}$
59	"UNIT WT?"		
60	PROMPT		
61	"UNIT WT. WATER="		
62	FS? 55		
63	XEQ 01		
64	STO 05		$\gamma_W \rightarrow R_{05}$
65	2		
66	PI		
67	*		
68	RCL 02		
69	/		
70	X↑2		
71	RCL 01		
72	*		
73	RCL 00		
74	/		
75	STO 06		$Gt = \left(\frac{2\pi}{T}\right)^2 \frac{d}{g} \rightarrow R_{06}$
76	4.0		
77	Y↑X		
78	0.0675		
79	*		
80	RCL 06		
81	3.0		
82	Y↑X		
83	0.0864		
84	*		
85	+		
86	RCL 06		
87	X↑2		
88	0.4622		
89	*		
90	+		
91	RCL 06		
92	0.6522		
93	*		
94	+		
95	1		
96	+		
97	1/X		
98	RCL 06		
99	+		
100	1/X		
101	RCL 00		
102	*		
103	RCL 01		
104	*		
105	SQRT		
106	RCL 02		
107	*		
108	STO 08		$L \rightarrow R_{08}$
109	RCL 01		
110	RCL 08		
111	/		
112	STO 10		$\Delta = \frac{d}{L} \rightarrow R_{10}$
113	2		
114	*		
115	PI		
116	*		
117	STO 11		$2\pi\Delta \rightarrow R_{11}$

109R-41CV-10

STEP	KEY ENTRY	KEY CODE	COMMENTS
118	XEQ "COSH"		
119	STO 12		$C1 \rightarrow R_{12}$
120	RCL 11		
121	XEQ "SINH"		
122	STO 13		$S1 \rightarrow R_{13}$
123	RCL 12		
124	/		
125	STO 14		$T1 \rightarrow R_{14}$
126	RCL 12		
127	X↑2		
128	4		
129	*		
130	1/X		
131	CHS		
132	RCL 13		
133	X↑2		
134	4		
135	*		
136	1/X		
137	3		
138	*		
139	+		
140	1		
141	+		
142	STO 15		$F5 \rightarrow R_{15}$
143	RCL 12		
144	X↑2		
145	4		
146	*		
147	1/X		
148	RCL 13		
149	X↑2		
150	4		
151	*		
152	1/X		
153	3		
154	*		
155	+		
156	STO 16		$F6 \rightarrow R_{16}$
157	RCL 01		
158	10.0		
159	/		
160	STO 17		$Dd = \frac{d}{N} \rightarrow R_{17}$
161	0.0		
162	STO [illegible]		$y_0 = 0 \rightarrow R_{18}$
163	STO [illegible]		
164	[illegible]		counter $\rightarrow R_{19}$
165	1.0		
166	STO [illegible]		
167	RCL [illegible]		
168	RCL [illegible]		
169	[illegible]		
170	STO 20		$E = y_0/L \rightarrow R_{20}$
171	RCL 19		
172	+		
173	2		
174	*		

STEP	KEY ENTRY	KEY CODE	COMMENTS
175	PI		
176	*		
177	STO 11		
178	XEQ "COSH"		
179	STO 21		$C2 \rightarrow R_{21}$
180	RCL 11		
181	XEQ "SINH"		
182	STO 22		$S2 \rightarrow R_{22}$
183	RCL 10		
184	2		
185	*		
186	RCL 20		
187	+		
188	2		
189	*		
190	PI		
191	*		
192	STO 11		
193	XEQ "COSH"		
194	STO 23		$C3 \rightarrow R_{23}$
195	RCL 11		
196	XEQ "SINH"		
197	STO 24		$S3 \rightarrow R_{24}$
198	RCL 20		
199	2		
200	*		
201	PI		
202	*		
203	STO 11		
204	XEQ "COSH"		
205	STO 25		$C4 \rightarrow R_{25}$
206	RCL 11		
207	XEQ "SINH"		
208	STO 26		$S4 \rightarrow R_{26}$
209	RCL 22		
210	RCL 13		
211	/		
212	STO 27		$F1 \rightarrow R_{27}$
213	RCL 21		
214	RCL 13		
215	/		
216	STO 28		$F2 \rightarrow R_{28}$
217	RCL 26		
218	RCL 13		
219	X↑2		
220	[illegible]		
221	STO 29		$F3 \rightarrow R_{29}$
222	RCL [illegible]		
223	RCL 13		
224	[illegible]		
225	RCL 12		
226	[illegible]		
227	STO 30		$F4 \rightarrow R_{30}$
228	RCL 21		
229	RCL 12		
230	/		
231	2		

109R-41CV-11

STEP	KEY ENTRY	KEY CODE	COMMENTS
232	*		
233	CHS		
234	RCL 25		
235	RCL 13		
236	X↑2		
237	/		
238	+		
239	0.75		
240	*		
241	RCL 14		
242	RCL 24		
243	*		
244	2		
245	*		
246	CHS		
247	+		
248	STO 11		(quantity) → R_{11}
249	RCL 12		
250	X↑2		
251	4		
252	*		
253	1/X		
254	CHS		
255	1		
256	+		
257	RCL 23		
258	*		
259	+		
260	STO 32		F7 → R_{32}
261	RCL 23		
262	4		
263	/		
264	RCL 13		
265	X↑2		
266	/		
267	RCL 11		
268	+		
269	STO 33		F8 → R_{33}
270	1.0		
271	RCL 04		
272	-		
273	X↑2		
274	RCL 16		
275	*		
276	RCL 04		
277	1		
278	+		
279	X↑2		
280	RCL 15		
281	*		
282	+		
283	PI		
284	*		
285	RCL 03		
286	X↑2		
287	*		
288	RCL 27		
289	*		
290	RCL 28		
291	*		
292	4		
293	/		
294	RCL 08		
295	/		
296	RCL 04		
297	1		
298	+		
299	RCL 03		
300	*		
301	RCL 27		
302	*		
303	2		
304	/		
305	+		Miche-Rundgren
306	RCL 18		
307	+		
308	STO 34		$y_c(k) \rightarrow R_{34}$
309	RCL 04		
310	1		
311	+		
312	RCL 03		
313	*		
314	RCL 27		
315	*		
316	CHS		
317	RCL 34		
318	+		
319	STO 35		$y_t(k) \rightarrow R_{35}$
320	1		
321	RCL 04		
322	-		
323	X↑2		
324	RCL 33		
325	*		
326	1		
327	RCL 04		
328	+		
329	X↑2		
330	RCL 32		
331	*		
332	+		
333	PI		
334	*		
335	RCL 07		
336	X↑2		
337	*		
338	RCL 24		
339	*		
340	4		
341	/		
342	RCL 08		
343	/		
344	1		

109R-41CV-12

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
345	RCL 04			402	*		Sainflou
346	+			403	+		
347	RCL 03			404	RCL 18		
348	*			405	+		
349	RCL 30			406	STO 41		$y_c(k) \to R_{41}$
350	*			407	RCL 03		
351	2			408	2		
352	/			409	*		
353	+			410	RCL 27		
354	RCL 19			411	*		
355	+			412	-		
356	CHS			413	STO 42		$y_t(k) \to R_{42}$
357	RCL 05			414	RCL 30		
358	*			415	RCL 03		
359	STO 49			416	*		
360	XEQ 06			417	RCL 18		
361	ST+ 37		$\Sigma P_c(k) \to R_{37}$	418	+		
362	RCL 04			419	CHS		
363	1			420	RCL 05		
364	+			421	*		
365	RCL 03			422	STO 51		
366	*			423	XEQ 06		
367	RCL 05			424	ST+ 44		$\Sigma P_c(k) \to R_{44}$
368	*			425	RCL 30		
369	RCL 30			426	RCL 03		
370	*			427	*		
371	RCL 49			428	RCL 18		
372	+			429	-		
373	STO 50			430	RCL 05		
374	XEQ 06			431	*		
375	ST+ 38		$\Sigma P_t(k) \to R_{38}$	432	STO 52		
376	RCL 34			433	XEQ 06		
377	RCL 01			434	ST+ 45		$\Sigma P_t(k) \to R_{45}$
378	+			435	RCL 41		
379	RCL 49			436	RCL 01		
380	*			437	+		
381	XEQ 06			438	RCL 51		
382	ST+ 39		$\Sigma M\ (k) \to R_{39}$	439	*		
383	RCL 35			440	XEQ 06		
384	RCL 01			441	ST+ 46		$\Sigma M_c(k) \to R_{46}$
385	+			442	RCL 42		
386	RCL 50			443	RCL 01		
387	*			444	+		
388	XEQ 06			445	RCL 52		
389	ST+ 40		$\Sigma M_t(k) \to R_{40}$	446	*		
390	RCL 27			447	XEQ 06		
391	RCL 29			448	ST+ 47		$\Sigma M_t(k) \to R_{47}$
392	*			449	RCL 17		
393	RCL 03			450	ST- 18		
394	X↑2			451	RCL 18		
395	*			452	11.8		
396	PI			453	X=Y?		
397	*			454	GTO 05		
398	RCL 02			455	GTO 04		
399	/			456	♦LBL 05		
400	RCL 27			457	FS? 55		
401	RCL 03						

109R-41CV-13

STEP	KEY ENTRY	KEY CODE	COMMENTS
458	ADV		
459	RCL 34		
460	ABS		
461	ST+ 54		
462	RCL 54		
463	"YC-MR="		"y_c - MR ="
464	ARCL X		
465	AVIEW		
466	TONE 6		
467	RCL 35		
468	ABS		
469	ST+ 55		
470	RCL 55		
471	"YT-MR="		"y_t - MR ="
472	ARCL X		
473	AVIEW		
474	TONE 7		
475	RCL 41		
476	ABS		
477	ST+ 56		
478	RCL 56		
479	"YC-SF="		"y_c - SF ="
480	ARCL X		
481	AVIEW		
482	TONE 8		
483	RCL 42		
484	ABS		
485	ST+ 57		
486	RCL 57		
487	"YT-SF="		"y_t - SF ="
488	ARCL X		
489	AVIEW		
490	TONE 9		
491	"LOW WALL HT?"		Low Wall Height Option
492	AON		
493	PROMPT		
494	AOFF		
495	ASTO Y		
496	CLA		
497	"Y"		
498	ASTO X		
499	CLA		
500	X=Y?		
501	GTO 12		
502	GTO 13		
503	♦LBL 12		
504	FS? 55		
505	ADV		
506	SF 01		
507	"WALL HT?"		
508	PROMPT		
509	FS? 55		
510	ADV		
511	"WALL HT="		
512	FS? 55		
513	XEQ 02		

STEP	KEY ENTRY	KEY CODE	COMMENTS
514	STO 09		$b \rightarrow R_{09}$
515	♦LBL 13		
516	"RUBBLE FDN?"		Rubble Foundation Option
517	AON		
518	PROMPT		
519	AOFF		
520	ASTO Y		
521	CLA		
522	"Y"		
523	ASTO X		
524	CLA		
525	X=Y?		
526	GTO 14		
527	GTO 15		
528	♦LBL 14		
529	SF 02		
530	"RUBBLE HT?"		
531	PROMPT		
532	"RUBBLE HT="		
533	FS? 55		
534	XEQ 02		
535	STO 07		$b' \rightarrow R_{07}$
536	♦LBL 15		
537	FS? 55		
538	ADV		
539	"MICHE-R"		Miche-Rundgren
540	AVIEW		
541	RCL 37		
542	30		
543	/		
544	RCL 54		
545	*		
546	XEQ 16		
547	"PC="		"P_c ="
548	ARCL X		
549	AVIEW		
550	TONE 2		
551	STOP		
552	RCL 38		
553	30		
554	/		
555	RCL 55		
556	*		
557	XEQ 16		
558	"PT="		"P_t ="
559	ARCL Y		
560	AVIEW		
561	TONE 3		
562	STOP		
563	RCL 39		
564	30		
565	/		
566	RCL 54		
567	*		
568	XEQ 17		
569	"PC="		"M_c ="
570	ARCL Y		

109R-41CV-14

STEP	KEY ENTRY	KEY CODE	COMMENTS
571	AVIEW		
572	TONE 4		
573	STOP		
574	RCL 40		
575	30		
576	/		
577	RCL 55		
578	*		
579	XEQ 17		
580	"MT="		"M_t ="
581	ARCL X		
582	AVIEW		
583	TONE 5		
584	STOP		
585	FS? 55		
586	ADV		
587	"SAINFLOU"		sainflou
588	AVIEW		
589	RCL 44		
590	30		
591	/		
592	RCL 56		
593	*		
594	XEQ 16		
595	"PC="		"P_c ="
596	ARCL X		
597	AVIEW		
598	TONE 6		
599	STOP		
600	RCL 45		
601	30		
602	/		
603	RCL 57		
604	*		
605	XEQ 15		
606	"PT="		"P_t ="
607	ARCL X		
608	AVIEW		
609	TONE 7		
610	STOP		
611	RCL 46		
612	30		
613	/		
614	RCL 56		
615	*		
616	XEQ 17		
617	"MC="		"M_c ="
618	ARCL X		
619	AVIEW		
620	TONE 8		
621	STOP		
622	RCL 47		
623	30		
624	/		
625	RCL 57		
626	*		
627	XEQ 17		

STEP	KEY ENTRY	KEY CODE	COMMENTS
628	"MT="		"M_t ="
629	ARCL X		
630	AVIEW		
631	TONE 9		
632	STOP		
633	CF 01		
634	CF 02		
635	GTO 11		
636	♦LBL 02		
637	PRA		
638	PRX		
639	RTN		
640	♦LBL "COSH"		cosh( ) subroutine
641	STO 11		
642	E↑X		
643	RCL 11		
644	CHS		
645	E↑X		
646	+		
647	2		
648	/		
649	RTN		
650	♦LBL "SINH"		sinh( ) subroutine
651	STO 11		
652	E↑X		
653	RCL 11		
654	CHS		
655	E↑X		
656	-		
657	2		
658	/		
659	RTN		
660	♦LBL 06		Simpson's Rule subroutine
661	STO 11		
662	RCL 19		
663	1.0		
664	X<>Y		
665	X=Y?		
666	GTO 07		
667	11.0		
668	X<>Y		
669	X=Y?		
670	GTO 10		
671	RCL 19		
672	ENTER↑		
673	2		
674	MOD		
675	X=0?		
676	GTO 09		
677	RCL 11		
678	2		
679	*		
680	GTO 09		
681	♦LBL 08		
682	RCL 11		
683	4		

109R-41CV-15

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS

```
694 *
695 GTO 09
696•LBL 07
697 RCL 34
688 STO 54
689 RCL 35
690 STO 55
691 RCL 41
692 STO 56
693 RCL 42
694 STO 57
695•LBL 10
696 RCL 11
697•LBL 09
698 RTN
699•LBL 16
700 STO 31
701 STO 11
702 LASTX
703 STO 36
704 FC? 01
705 GTO 19
706 RCL 09
707 RCL 36
708 /
709 STO 48
710 1.0
711 X<=Y?
712 GTO 19
713 2
714 RCL 48
715 -
716 RCL 49
717 *
718 RCL 31
719 *
720 STO 31
721•LBL 19
722 FC? 02
723 GTO 20
724 RCL 07
725 RCL 36
726 /
727 STO 49
728 1.0
729 X<=Y?
730 GTO 18
731 3
732 RCL 49
733 -
734 RCL 49
735 *
736 CHS
737 RCL 11
738 *
739 RCL 31
740 +
```

Force Reduction Subroutine

low wall reduction

Rubble Reduction

```
741 STO 31
742 GTO 20
743•LBL 18
744 RCL 31
745 RCL 11
746 -
747 STO 31
748•LBL 20
749 RCL 31
750 RTN
751•LBL 17
752 STO 31
753 STO 11
754 LASTX
755 STO 36
756 FC? 01
757 GTO 22
758 RCL 09
759 RCL 36
760 /
761 STO 48
762 1.0
763 X<=Y?
764 GTO 22
765 3
766 RCL 48
767 2
768 *
769 -
770 RCL 48
771 X↑2
772 *
773 RCL 31
774 *
775 STO 31
776•LBL 22
777 FC? 02
778 GTO 23
779 RCL 07
780 RCL 36
781 /
792 STO 49
793 1.0
794 X<=Y?
785 GTO 21
786 3
787 RCL 49
788 2
789 *
790 -
791 RCL 49
792 X↑2
793 *
794 CHS
795 RCL 11
796 *
```

Moment Reduction Subroutine

low wall reduction

Rubble Reduction

109R-41CV-16

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS

```
797 RCL 31
798 +
799 STO 31
800 GTO 23
801♦LBL 21
802 RCL 31
803 RCL 11
804 -
805 STO 31
806♦LBL 23
807 RCL 31
808 RTN
809 END
```

109R-41CV-17

Program Description

Program Title	110R-41CV Non-breaking Wave Pressure Distribution on Vertical Face Structures - Miche-Rundgren and Sainflou Solutions (RPN Logic)		
Name	Julie Dean	**Date**	8/83
Address	U. S. Army Engineer Waterways Experiment Station Coastal Engineering Research Center		
City	P. O. Box 631 Vicksburg	**State** Mississippi	**Zip Code** 39180-0631

Program Description, Equations, Variables, etc.

This program calculates non-breaking pressure distributions when the wave crest is at the structure and when the wave trough is at the structure using both the Miche-Rundgren and Sainflou equations. The solution corresponding to Figure 7-91 or 7-94 of the Shore Protection Manual is the solution with an overall lower pressure value. Input values are the water depth at the structure d, wave period T, incident wave height H_i, reflection coefficient χ, and unit weight of water γ_w. The user is given the option of calculating the pressure distribution values using either or both the Miche-Rundgren and Sainflou solutions. This program is identical to 109R except that the pressure distribution is printed out without integrating to obtain force. The algorithm uses U. S. Customary or Metric system of units.

REFERENCES

Hughes, S. A., August 1982, Basic Program: "WAVEFOR", available from Coastal Engineering Research Center, U. S. Army Engineer Waterways Experiment Station, Vicksburg, MS 39180-0631.

U. S. Army Corps of Engineers, Coastal Engineering Research Center, CETN-I-21, 12/82.

U. S. Army Corps of Engineers, Coastal Engineering Research Center, Shore Protection Manual, Chapter 7 (1984).

Operating Limits and Warnings

Because of the large number of output values, this program has been written for use with printer only. It can easily be modified to run without the printer by deleting the printer instructions and inserting R/S statements where output values are desired.

User Instructions

110R-41CV Non-Breaking Wave Pressure Distribution on Vertical Face Structures - Miche-Rundgren and Sainflou Solutions (RPN Logic)

SIZE: 063

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
1	LOAD PROGRAM (NBPD)		[XEQ] "NBPD"	E OR M?
2	CHOOSE U.S. CUSTOMARY OR METRIC			
	UNITS		US or M, [R/S]	DEPTH?
3	ENTER DEPTH (feet or meters)	d	[R/S]	PERIOD?
4	ENTER WAVE PERIOD (seconds)	T	[R/S]	WAVE HT.?
5	ENTER INCIDENT WAVE HEIGHT			
	(feet or meters)	H_i	[R/S]	REFLEC COEFF?
6	ENTER REFLECTION COEFFICENT	χ	[R/S]	UNIT WT?
7	ENTER UNIT WEIGHT OF			
	WATER (lb/ft^3 or kg/m^3)	γ_w	[R/S]	MR?
8	ANSWER YES OR NO TO			
	MICHE-RUNDGREN PRESSURE			
	DISTRIBUTION		Y or N, [R/S]	SF?
9	ANSWER YES OR NO TO			
	SAINFLOU PRESSURE DISTRIBU-			
	TION		Y or N, [R/S]	
10	READ ELEVATIONS (ft. or m)			
	READ PRESSURES (lb/ft^2 or kg/m^2)			
	The solution corresponding to			
	Figure 7-91 or 7-94 of the			
	Shore Protection Manual is the			
	solution with an overall lower			
	pressure value.			

110R-41CV-2

User Instructions

SIZE:

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY

Example Problem:
- U.S. Customary Units

depth = 10 ft.
period = 6 sec.
H_i = 5 ft.
χ = 1.0
γ_w = 64 lb/ft^3

Read Miche-Rundgren:
elevation (ft.)
pressure (lb/ft^2)

Read Sainflou:
elevation (ft.)
pressure (lb/ft^2)

Since the Sainflou pressure distribution provides lower pressures than the Miche-Rundgren theory, the Sainflou solution corresponds to SPM Figure 7-91.

```
NON-BRKG PRESSURE DIST.

US CUST. UNITS

DEPTH=
         10.0000    ***
PERIOD=
          6.0000    ***
WAVE HT.=
          5.0000    ***
REFLECTION COEFF.=
          1.0000    ***
UNIT WT. WATER=
         64.0000    ***

MICHE-R...CREST AT WALL

ELEVATION  PRESSURE
  8.5929     0.0000
  6.5401    90.0809
  4.5516   181.6486
  2.6195   274.8357
  0.7325   369.7969
 -1.1147   466.7113
 -2.9289   565.7828
 -4.7184   667.2433
 -6.4992   771.3541
 -8.2476   878.4092
-10.0000   988.7386

MICHE-R...TROUGH AT WALL

ELEVATION  PRESSURE
 -1.4071     0.0000
 -2.7541    39.8481
 -3.2707    80.9910
 -4.1619   123.3686
 -5.0319   166.9416
 -5.8846   211.6934
 -6.7235   257.6259
 -7.5517   304.7705
 -8.3720   353.1803
 -9.1877   402.9363
-10.0000   454.1494

SAINFLOU...CREST AT WALL

ELEVATION  PRESSURE
  6.4053     0.0000
  4.6568    89.1164
  2.9439   178.3298
  1.2618   267.7335
 -0.3941   357.4277
 -2.0279   447.5094
 -3.6436   538.0785
 -5.2450   629.2364
 -6.8358   721.0869
 -8.4197   813.7365
-10.0000   907.2946

SAINFLOU..TROUGH AT WALL

ELEVATION  PRESSURE
 -3.5947     0.0000
 -4.2373    38.8836
 -4.8784    77.6712
 -5.5186   116.2665
 -6.1585   154.5723
 -6.7983   192.4906
 -7.4382   229.9215
 -8.0794   266.7636
 -8.7187   302.9131
 -9.3597   338.2635
-10.0000   372.7054
END
```

110R-41CV-3

User Instructions

SIZE:

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY
	Example Problem:			
	- Metric Units			
	depth = 3.05m			
	period = 6sec.			
	H_i = 1.52m			
	χ = 1.0			
	γ_w = 1025.18 kg/m^3			
	Read Miche-Rundgren:			
	elevation (m)			
	pressure (kg/m^2)			
	Read Sainflou:			
	elevation (m)			
	pressure (kg/m^2)			
	Since the Sainflou			
	pressure distribution			
	provides lower pres-			
	sures than the			
	Miche-Rundgren theory,			
	the Sainflou solution			
	corresponds to SPM Figure 7-91.			

```
NON-BRKG PRESSURE DIST.

METRIC UNITS

DEPTH=
          3.0500     ***
PERIOD=
          6.0000     ***
WAVE HT.=
          1.5200     ***
REFLECTION COEFF.=
          1.0000     ***
UNIT WT. WATER=
      1,025.1800     ***
```

MICHE-R...CREST AT WALL

ELEVATION	PRESSURE
2.6078	0.0000
1.9833	439.5090
1.3783	886.2443
0.7901	1,340.9499
0.2162	1,804.0756
-0.3457	2,276.7932
-0.8980	2,759.9939
-1.4425	3,254.9075
-1.9815	3,762.4924
-2.5167	4,284.4995
-3.0500	4,822.7992

MICHE-R...TROUGH AT WALL

ELEVATION	PRESSURE
-0.4322	0.0000
-0.7205	194.9660
-0.9996	396.2226
-1.2710	603.4734
-1.5360	816.5249
-1.7959	1,035.2984
-2.0514	1,259.7845
-2.3029	1,490.1450
-2.5539	1,726.5408
-2.8023	1,969.6595
-3.0500	2,219.7145

SAINFLOU...CREST AT WALL

ELEVATION	PRESSURE
1.9459	0.0000
1.4135	434.9514
0.8919	870.3707
0.3797	1,306.7274
-0.1246	1,744.4952
-0.6231	2,184.1519
-1.1142	2,626.1841
-1.6019	3,071.0866
-2.0963	3,519.3651
-2.5627	3,971.5369
-3.0500	4,428.1412

SAINFLOU..TROUGH AT WALL

ELEVATION	PRESSURE
-1.0941	0.0000
-1.2903	190.4054
-1.4960	380.7433
-1.6915	569.3520
-1.8769	756.9442
-2.0722	942.6471
-2.2676	1,125.9747
-2.4631	1,306.4320
-2.6587	1,483.5133
-2.8543	1,656.6994
-3.0500	1,825.4563

END

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
01	♦LBL "NBPD"			60	PRX		
02	"NON-BRKG PRESSU"			61	STO 05		$\gamma_W \rightarrow R_{05}$
03	"├RE DIST."			62	2		
04	AVIEW			63	PI		
05	ADV			64	*		
06	CLRG			65	RCL 02		
07	CF 00			66	/		
08	CF 01			67	X↑2		
09	"US OR M?"			68	RCL 01		
10	AON			69	*		
11	PROMPT			70	RCL 00		
12	AOFF			71	/		
13	ASTO Y			72	STO 06		$Gt \rightarrow R_{06}$
14	CLA			73	4.0		
15	"US"			74	Y↑X		
16	ASTO X			75	0.0675		
17	CLA			76	*		
18	X=Y?			77	RCL 06		
19	GTO 02			78	3.0		
20	"METRIC UNITS"			79	Y↑X		
21	AVIEW			80	0.0864		
22	9.81			81	*		
23	GTO 03			82	+		
24	♦LBL 02			83	RCL 06		
25	"US CUST. UNITS"			84	X↑2		
26	AVIEW			85	0.4622		
27	32.2			86	*		
28	♦LBL 03			87	+		
29	STO 00		$g \rightarrow R_{00}$	88	RCL 06		
30	ADV			89	0.6522		
31	"DEPTH?"			90	*		
32	PROMPT			91	+		
33	"DEPTH="			92	1		
34	PRA			93	+		
35	PRX			94	1/X		
36	STO 01		$d \rightarrow R_{01}$	95	RCL 06		
37	"PERIOD?"			96	+		
38	PROMPT			97	1/X		
39	"PERIOD="			98	RCL 00		
40	PRA			99	*		
41	PRX			100	RCL 01		
42	STO 02		$T \rightarrow R_{02}$	101	*		
43	"WAVE HT.?"			102	SQRT		
44	PROMPT			103	RCL 02		
45	"WAVE HT.="			104	*		
46	PRA			105	STO 08		$L \rightarrow R_{08}$
47	PRX			106	RCL 01		
48	STO 03		$H_i \rightarrow R_{03}$	107	RCL 08		
49	"REFLEC. COEFF.?"			108	/		
50	PROMPT			109	STO 10		$\Delta \rightarrow R_{10}$
51	"REFLECTION COEF"			110	2		
52	"├F.="			111	*		
53	PRA			112	PI		
54	PRX			113	*		
55	STO 04		$\chi \rightarrow R_{04}$	114	STO 11		$(\ \ ) \rightarrow R_{11}$
56	"UNIT WT?"			115	XEQ "COSH"		
57	PROMPT			116	STO 12		$Cl \rightarrow R_{12}$
58	"UNIT WT. WATER="			117	RCL 11		
59	PRA			118	XEQ "SINH"		$Sl \rightarrow R_{13}$
				119	STO 13		

110R-41CV-5

STEP	KEY ENTRY	KEY CODE	COMMENTS
120	RCL 12		
121	/		
122	STO 14		$T1 \rightarrow R_{14}$
123	RCL 12		
124	X↑2		
125	4		
126	*		
127	1/X		
128	CHS		
129	RCL 13		
130	X↑2		
131	4		
132	*		
133	1/X		
134	3		
135	*		
136	+		
137	1		
138	+		
139	STO 15		$F5 \rightarrow R_{15}$
140	RCL 12		
141	X↑2		
142	4		
143	*		
144	1/X		
145	RCL 13		
146	X↑2		
147	4		
148	*		
149	1/X		
150	3		
151	*		
152	+		
153	STO 16		$F6 \rightarrow R_{16}$
154	RCL 21		
155	12.0		
156	[illegible]		
157	STO 17		$Dd \rightarrow R_{17}$
158	0.0		
159	STO 18		$y_0 = 0 \rightarrow R_{18}$
160	STO 19		$0 \rightarrow R_{19}$ (counter)
161	♦LBL 04		
162	1.0		
163	ST+ 19		
164	RCL 11		
165	RCL 04		
166	[illegible]		
167	STO 20		$E \rightarrow R_{20}$
168	RCL 10		
169	+		
170	2		
171	*		
172	PI		
173	*		
174	STO 11		
175	XEQ "COSH"		
176	STO 21		$C2 \rightarrow R_{21}$
177	RCL 11		
178	XEQ "SINH"		
179	STO 22		$S2 \rightarrow R_{22}$
180	RCL 10		
181	3		
182	*		
183	RCL 20		
184	+		
185	2		
186	*		
187	PI		
188	*		
189	STO 11		
190	XEQ "COSH"		
191	STO 23		$C3 \rightarrow R_{23}$
192	RCL 11		
193	XEQ "SINH"		
194	STO 24		$S3 \rightarrow R_{24}$
195	RCL 20		
196	2		
197	*		
198	PI		
199	*		
200	STO 11		
201	XEQ "COSH"		
202	STO 25		$C4 \rightarrow R_{25}$
203	RCL 11		
204	XEQ "SINH"		
205	STO 26		$S4 \rightarrow R_{26}$
206	RCL 22		
207	RCL 13		
208	/		
209	STO 27		$F1 \rightarrow R_{27}$
210	RCL 21		
211	RCL 13		
212	/		
213	STO 28		$F2 \rightarrow R_{28}$
214	RCL 26		
215	RCL 13		
216	X↑2		
217	/		
218	STO 29		$F3 \rightarrow R_{29}$
219	RCL 26		
220	RCL 13		
221	[illegible]		
222	RCL 12		
223	/		
224	STO 30		$F4 \rightarrow R_{30}$
225	RCL 21		
226	RCL 12		
227	[illegible]		
228	2		
229	*		
230	CHS		
231	RCL 25		
232	RCL 13		
233	X↑2		
234	/		
235	+		

110R-41CV-6

STEP	KEY ENTRY	KEY CODE	COMMENTS
236	0.75		
237	*		
238	RCL 14		
239	RCL 24		
240	*		
241	2		
242	*		
243	CHS		
244	+		
245	STO 11		(quantity) → R_{11}
246	RCL 12		
247	X↑2		
248	4		
249	*		
250	1/X		
251	CHS		
252	1		
253	+		
254	RCL 23		
255	*		
256	+		
257	STO 32		F7 → R_{32}
258	RCL 23		
259	+		
260	/		
261	RCL 12		
262	X↑2		
263	/		
264	RCL 11		
265	+		
266	STO 33		F8 → R_{33}
267	FS? 00		
268	GTO 12		
269	FS? 01		
270	GTO 14		
271	"MP?"		
272	AON		
273	PROMPT		
274	AOFF		
275	ASTO Y		
276	CLA		
277	"N"		
278	ASTO X		
279	CLA		
280	X=Y?		
281	GTO 11		
282	SF 00		
283	ADV		
284	"⊢ICHE-F...PRES"		
285	"⊢ AT WELL"		
286	PRA		
287	ADV		
288	"ELEVATION PRES"		
289	"⊢SURE"		
290	PRA		
291	♦LBL 12		
292	FS? 01		

STEP	KEY ENTRY	KEY CODE	COMMENTS
293	GTO 14		
294	1.0		
295	RCL 04		
296	-		
297	X↑2		
298	RCL 16		
299	*		
300	RCL 04		
301	1		
302	+		
303	X↑2		
304	RCL 15		
305	*		
306	+		
307	PI		
308	*		
309	RCL 03		
310	X↑2		
311	*		
312	RCL 27		
313	*		
314	RCL 26		
315	*		
316	4		
317	/		
318	RCL 09		
319	/		
320	RCL 04		
321	1		
322	+		
323	RCL 03		
324	*		
325	RCL 27		
326	*		
327	2		
328	/		
329	+		
330	RCL 18		
331	+		
332	STO 34		y_c
333	ACX		
334	6		
335	SKPCHR		
336	RCL 04		
337	1		
338	+		
339	RCL 03		
340	*		
341	RCL 27		
342	*		
343	CF3		
344	RCL 34		
345	+		
346	STO 35		y_t
347	RCL 19		
348	40		
349	+		

110R-41CV-7

STEP	KEY ENTRY	KEY CODE	COMMENTS
350	STO 40		
351	RCL 35		
352	STO IND 40		
353	1.0		
354	RCL 04		
355	-		
356	X↑2		
357	RCL 33		
358	*		
359	1		
360	RCL 04		
361	+		
362	X↑2		
363	RCL 32		
364	*		
365	+		
366	PI		
367	*		
368	RCL 03		
369	X↑2		
370	*		
371	RCL 29		
372	*		
373	4		
374	/		
375	RCL 08		
376	/		
377	1		
378	RCL 04		
379	+		
380	RCL 03		
381	*		
382	RCL 30		
383	*		
384	2		
385	/		
386	+		
387	RCL 18		
388	+		
389	CHS		
390	RCL 05		
391	*		
392	STO 36		Pc
393	ACX		
394	PRBUF		
395	RCL 04		
396	1		
397	+		
398	RCL 03		
399	*		
400	RCL 05		
401	+		
402	RCL 30		
403	*		
404	RCL 36		Pt
405	+		
406	STO 35		

STEP	KEY ENTRY	KEY CODE	COMMENTS
407	RCL 19		
408	51		
409	+		
410	STO 40		
411	RCL 35		
412	STO IND 40		
413	RCL 17		
414	ST- 18		
415	RCL 19		
416	11.0		
417	X≠Y?		
418	GTO 04		
419	0.0		
420	STO 19		
421	ADV		
422	"MICHE-R...TROUG"		
423	"⊢H AT WALL"		
424	PRA		
425	ADV		
426	"ELEVATION PRES"		
427	"⊢SURE"		
428	PRA		
429	♦LBL 10		
430	RCL 19		
431	1		
432	+		
433	STO 19		
434	40		
435	+		
436	STO 40		
437	RCL IND 40		
438	ACX		
439	6		
440	SKPCHR		
441	RCL 19		
442	51		
443	+		
444	STO 40		
445	RCL IND 40		
446	ACX		
447	PRBUF		
448	RCL 19		
449	11.0		
450	X=Y?		
451	GTO 11		
452	GTO 10		
453	FS? 01		
454	GTO 14		
455	♦LBL 11		
456	"SF?"		
457	AON		
458	PROMPT		
459	AOFF		
460	ASTO Y		
461	CLA		
462	"N"		

110R-41CV-8

STEP	KEY ENTRY	KEY CODE	COMMENTS
463	ASTO X		
464	CLA		
465	X=Y?		
466	GTO 13		
467	SF 01		
468	ADV		
469	"SAINFLOU...CRES"		
470	"⊢T AT WALL"		
471	PRA		
472	ADV		
473	"ELEVATION PRES"		
474	"⊢SURE"		
475	PRA		
476	0.0		
477	STO 18		
478	STO 19		
479	GTO 04		
480	•LBL 14		
481	RCL 27		
482	RCL 28		
483	*		
484	RCL 03		
485	X↑2		
486	*		
487	PI		
488	*		
489	RCL 03		
490	/		
491	RCL 27		
492	RCL 03		
493	*		
494	+		
495	RCL 18		
496	+		
497	STO 37		Yc
498	ACX		
499	6		
500	SKPCHR		
501	RCL 37		
502	RCL 03		
503	2		
504	*		
505	RCL 27		
506	*		
507	-		
508	STO 38		Yt
509	RCL 19		
510	40		
511	+		
512	STO 40		
513	RCL 38		
514	STO IND 40		
515	RCL 30		
516	RCL 03		
517	*		
518	RCL 18		
519	+		
520	CHS		
521	RCL 05		
522	*		
523	STO 39		Pc
524	ACX		
525	PRBUF		
526	RCL 30		
527	RCL 03		
528	*		
529	RCL 18		
530	-		
531	RCL 05		
532	*		
533	STO 38		Pt
534	RCL 19		
535	51		
536	+		
537	STO 40		
538	RCL 38		
539	STO IND 40		
540	RCL 17		
541	ST- 18		
542	RCL 19		
543	11.0		
544	X≠Y?		
545	GTO 04		
546	ADV		
547	"SAINFLOU..TROUG"		
548	"⊢H AT WALL"		
549	PRA		
550	ADV		
551	"ELEVATION PRES"		
552	"⊢SURE"		
553	PRA		
554	0.0		
555	STO 19		
556	•LBL 15		
557	RCL 19		
558	1		
559	+		
560	STO 19		
561	40		
562	+		
563	STO 40		
564	RCL IND 40		
565	ACX		
566	6		
567	SKPCHR		
568	RCL 19		
569	51		
570	+		
571	STO 40		
572	RCL IND 40		
573	ACX		
574	PRBUF		

110R-41CV-9

STEP	KEY ENTRY	KEY CODE	COMMENTS
575	RCL 19		
576	11.0		
577	X=Y?		
578	GTO 13		
579	GTO 15		
580	♦LBL "COSH"		cosh( ) subroutine
561	STO 11		
582	E↑X		
583	RCL 11		
584	CHS		
585	E↑X		
536	+		
567	2		
588	/		
589	RTN		
590	♦LBL "SINH"		sinh( ) subroutine
591	STO 11		
592	E↑X		
593	RCL 11		
594	CHS		
595	E↑X		
596	-		
597	2		
598	/		
599	RTN		
600	♦LBL 13		
601	CF 01		
602	CF 00		
603	"END"		
604	AVIEW		
605	END		

110R-41CV-10

REFERENCES

Hughes, S. A. 1982 (Aug). Basic Program "WAVFOR," available from Coastal Engineering Research Center, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

Nielsen, P. 1982. "Explicit Formulae for Practical Wave Calculations," Coastal Engineering, pp 389-398.

Shore Protection Manual. 1984. 4th ed., 2 vols., US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, US Government Printing Office, Washington, DC.

US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center. 1982 (Dec). "Revised Nonbreaking Wave Forces and Moments," Coastal Engineering Technical Note I-21, Vicksburg, Miss.

Walton, T. L. 1982 (Nov). "Hand-Held Calculator Algorithms for Coastal Engineering (Second Series)," Coastal Engineering Technical Aid No. 82-4, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.

APPENDIX A: BLANK PROGRAM FORMS

Program Description

Program Title

Name **Date**

Address

City State Zip Code

Program Description, Equations, Variables, etc.

Operating Limits and Warnings

User Instructions

SIZE:

STEP	INSTRUCTIONS	INPUT	FUNCTION	DISPLAY

Program Listing

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS

END

FILMED

8-85

DTIC